(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
20 September 2001 (20.09.2001)

PCT

(10) International Publication Number
WO 01/69078 A1

(51) International Patent Classification[7]: F02N 11/04

(21) International Application Number: PCT/GB01/00840

(22) International Filing Date: 27 February 2001 (27.02.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0006114.3 15 March 2000 (15.03.2000) GB

(71) Applicant *(for all designated States except US)*: **BG INTELLECTUAL PROPERTY LTD** [GB/GB]; 100 Thames Valley Park Drive, Reading, Berkshire RG6 1PT (GB).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **ALDRIDGE, Wayne, Kenneth** [GB/GB]; The Nook, Church Street, Granby, Nottingham NG13 9PU (GB). **FRANCIS, George, McChesney** [GB/GB]; 19 Finwood Close, Solihull, West Midlands B92 9QN (GB). **REA, Isobel, Dorothy** [GB/GB]; 71 Albert Promenade, Loughborough, Leicestershire LE11 1RB (GB).

(74) Agent: **BOULT WADE TENNANT**; Verulam Gardens, 70 Gray's Inn Road, London WC1X 8BT (GB).

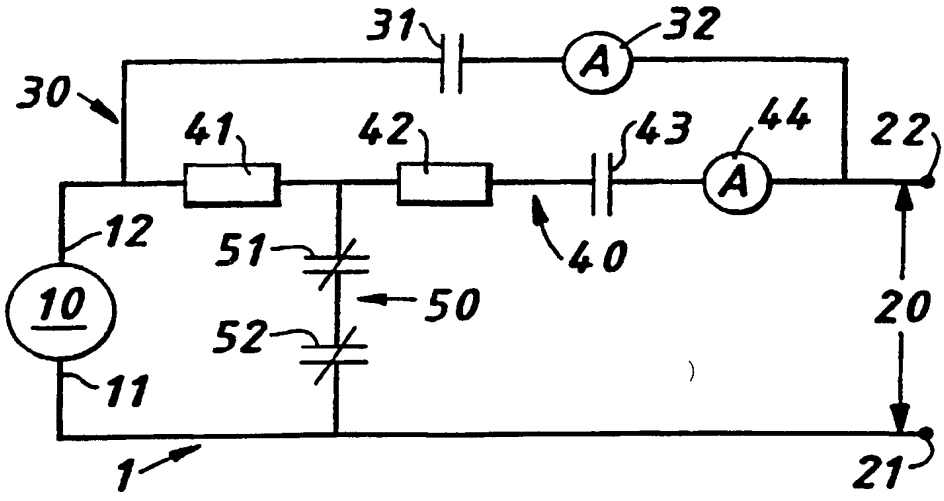
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: A METHOD AND A CONNECTOR ARRANGEMENT FOR CONNECTING AND DISCONNECTING A GENERATOR TO A CIRCUIT WITH AN EXISTING ALTERNATING CURRENT



(57) Abstract: A method and a connector arrangement for connecting and disconnecting an electrical generator, such as a prime mover driven alternator (10), to a circuit with an existing alternating current such as the mains electricity supply (20).

WO 01/69078 A1

A METHOD AND A CONNECTOR ARRANGEMENT FOR CONNECTING AND DISCONNECTING A GENERATOR TO A CIRCUIT WITH AN EXISTING ALTERNATING CURRENT

The present invention relates to a method and a connector arrangement for connecting and disconnecting an electrical generator such as a prime mover driven alternator to a circuit with an existing alternating current such as the mains electricity supply.

A number of problems are encountered when connecting and disconnecting an electrical generator to a circuit carrying an existing alternating current such as the mains electricity supply.

An electrical generator can be started in isolation until it reaches suitable power quality and the appropriate frequency and phase, and then connected to the mains electricity supply. However, the provision of a control device to monitor the power quality of a generator and then connect the generator to the mains electricity supply when the appropriate power quality has been achieved is expensive, increases the complexity of the device and is liable to error.

When disconnecting the electrical generator from the mains electricity supply, arcing is produced between the contacts of the switch used for disconnection. This arcing wears out the contacts of the switch impairing performance and

necessitating regular replacement which is inconvenient and expensive. Arcing also disturbs the quality of the mains electricity signal which is prohibited. Arcing can also cause damage to other components and the starting of fires and its prevention by for example the provision of an inert gas atmosphere is expensive.

It is an object of the present invention to overcome one or more of the above problems.

According to a first aspect of the present invention a method of connecting a prime mover driven electrical alternator having two terminals to a circuit with an existing alternating current comprises

connecting the two terminals of a prime mover driven alternator together through a suitably low impedance such that the prime mover arranged to drive the alternator does not move substantially and cannot make the alternator generate a current,

initialising the prime mover arranged to drive the alternator so that it is in a suitable condition to drive the alternator at the frequency of the alternating current in the circuit to which it is to be connected and

connecting the terminals of the alternator to a circuit with an existing alternating current to cause the alternator to start movement of the prime mover for the prime mover to drive the alternator to generate an alternating current with a suitable power quality for the circuit thereafter.

A Stirling engine is preferably used as the prime mover as it can be initialised by being heated by an external heat source and then remain in a state ready to be brought into operation extremely quickly. Starting the Stirling engine only requires a small amount of energy since the pistons, which are the moving part, are relatively light and can be accelerated from rest very easily. The acceleration of the pistons from rest is continued in the normal operation of the engine, by linear simple harmonic motion.

The starting energy is provided by applying the alternating current from the circuit to which the prime mover driven alternator is to be connected, which is usually mains power, to the stator of the alternator through a suitable impedance to limit the inrush current and to bring the alternator closely into phase with the mains.

According to a second aspect of the present invention a method of disconnecting a prime mover driven electrical

alternator from a circuit with an existing alternating current comprises

connecting an impedance in parallel with the prime mover driven electrical alternator, the impedance having a sufficiently low impedance to require a current in excess of that which the alternator is able to deliver to prevent the prime mover from driving the alternator and thus stalling the alternator and

disconnecting the alternator from the circuit with an existing alternating current.

By stalling the alternator before disconnecting it from the mains, the arcing caused when it is disconnected is substantially reduced.

According to a third aspect of the present invention an apparatus for connecting a prime mover driven alternator to a circuit with an existing alternating current comprises

an impedance switchable into and out of a parallel arrangement with the alternator, the impedance being of sufficiently low value that the prime mover cannot drive the alternator to produce a current around the parallel impedance and a switch to connect the prime mover driven alternator to the circuit with an existing alternating current.

According to a fourth aspect of the present invention an apparatus for disconnecting a prime mover driven alternator from a circuit with an existing alternating current comprises

an impedance switchable into a parallel arrangement with the alternator, the impedance being of sufficiently low value that the prime mover cannot drive the alternator to produce a current around the parallel impedance and a switch to disconnect the prime mover driven alternator from the circuit with an existing alternating current.

An example illustrating the present invention will now be described with reference to the accompanying drawings in which:

Figure 1 shows a connector arrangement for connecting a prime mover driven alternator to a circuit with an existing alternating current,

Figures 2 to 7 show the effective state of that circuit at various intervals,

Figure 8 shows a control system for controlling switches in the connector arrangement,

Figure 9 shows the sequence of steps followed by the control system to connect a prime mover driven alternator to a circuit with an existing alternating current and

Figure 10 shows the sequence of steps followed by the control system to disconnect a prime mover driven alternator from a circuit with an existing alternating current.

The prime mover which drives the alternator 10 in the present example shown in Figure 1 is a Stirling engine as is well known in the art, such as the one described in WO 94/04878 for example. However, any other suitable prime mover such as a gas engine, an internal combustion engine or a steam turbine for example would be suitable. Any suitable alternator may be used but in the present example a linear alternator has been found to work particularly well with the reciprocating Stirling engine. In the present example shown in Figure 1 the mains electricity supply 20 between neutral 21 and a live terminal 22 acts as the circuit with an existing alternating current. The alternator has two terminals 11, 12 one of which 11 is connected to neutral. The other terminal 12 of the alternator 10 is connectable to the live mains supply 22 by two parallel paths 30, 40. The first electrical path 30 has a switch 31 and a meter 32 in series and the second electrical path 40 has a first impedance 41, which in the present example is 10 ohms, a second impedance 42, which in the present example is 27 ohms,

a switch 43 and a meter 44 in series. Between impedances 41 and 42 a line 50 connected to neutral 21 is provided. The line 50 has two switches 51, 52 in series.

Before starting the Stirling engine and connecting the alternator to the mains supply, switches 31 and 43 are opened and switches 51 and 52 are closed to produce the effective circuit shown in figure 2 with resistor 41 connected around the alternator 10. The impedance of resistor 41 is selected to be sufficiently low such that the prime mover driven alternator 10 cannot produce a current required to pass through the resistor 41 so that the engine is stalled and kept in a stationary condition. The engine (not shown), which in this case is a Stirling engine, is then brought into a condition ready for use by applying heat to one end of its piston chamber and cooling the other end. When the engine is sufficiently "warmed up" to achieve steady state operation and it is desired to connect the alternator 10 to the mains electricity supply 20, switch 52 is opened and switch 43 is closed. Switches 52 and 43 are provided by a "break before make" switching arrangement as is well known in the art to ensure that switch 52 is open before switch 43 is closed. The connector arrangement is then effectively in the configuration shown in figure 3 with the alternator 10 connected to the mains 20 through the two impedances 41 and 42 in series. The particular total value of the impedances 41 and 42 is selected dependent upon the particular prime

mover and alternator combination that is used. In the present example, the sum of the series impedances has been selected at 37 ohms which dictates the current which passes through the coils of the alternator and which in turn dictates the force applied to the moving portion of the alternator within the coils which in this case is a piston. The force must be sufficient to start movement of the piston and yet must not be so excessive that it produces so much force that the piston damages the alternator or prime mover. As can be seen, the particular impedance value selected would be dependent upon the particular type of prime mover and alternator used. The connector arrangement 1 of the present invention is particularly suitable for use with a Stirling engine as the prime mover of the alternator as the Stirling engine can be powered by an external heat source and then remain in a steady state ready to be brought into operation extremely quickly. Furthermore, starting the engine only requires a small amount of energy since the piston is relatively light and can be accelerated from rest very easily. The acceleration of the piston from rest is continued in the normal operation of the engine by linear simple harmonic motion.

Starting the prime mover driven alternator in this manner ensures that the alternator 10 produces electricity of a suitable power quality for the mains electricity supply with the same frequency and in phase.

The connector arrangement 1 of the present invention is provided with a meter 44 which provides an indication of the current passing through line 40. After switch 43 is closed the current measured by meter 44 is checked to ensure that it is within expected parameters. This check provides an indication that the impedances 41, 42 and contacts of the switches 31, 43, 51, 52 are working satisfactorily. The current measured by meter 44 is read by a controller 101 which compares it with expected values to ensure that the connector arrangement 1 is functioning correctly. If the measured value is outside the desired values the control means performs an emergency shut down procedure as described later. However, under normal circumstances, the reading of meter 44 will be within expected parameters and so switch 31 is closed and switch 51 is opened to produce the effective circuit shown in Figure 4. Switches 31 and 51 are provided in a "make before break" configuration as is well known in the art. After a suitable period of time has elapsed for the current through line 30 to settle, for example 100 ms, the current through meter 32 is checked to see whether it is within normal operating parameters. If it is not then the connector arrangement undergoes emergency shut down procedures as are described later. However, under normal circumstances the current will be within normal parameters and switch 43 is then opened to eliminate the impedance provided by impedances 41 and 42 such that the prime mover driven alternator is directly connected to the mains as shown

in figure 5. Since in the present example switches 43 and 52 are formed together in a "break before make" arrangement the opening of switch 43 also closes switch 52. However, no current passes through line 50 because switch 51 remains open. The prime mover driven alternator 10 continues to be directly connected to the mains supply 20 as shown in figure 5 until it is desired to turn off the prime mover. During normal operation the current passing through meter 32 is monitored at regular intervals to ensure that the connector arrangement 1 is working satisfactorily and to ensure that the prime mover driven alternator is operating within its normal specification.

When it is desired to disconnect the prime mover driven alternator 10 from the mains supply 20 the heater of the Stirling engine which is used in the present example is turned off and the remaining heat in the Stirling engine is used up. When the Stirling engine drops below a critical temperature it starts drawing power from the mains 20 rather than supplying it as is well known in Stirling engine operation. A temperature detector 15 provided on the Stirling engine is connected to a controller 101 (see Figure 8) and when this critical temperature is reached, which for the Stirling engine used in the present example is 300°C, switch 51 is closed to produce the effective circuit shown in Figure 6 for a few milliseconds as the "make before break" switch arrangement of switches 31 and 52 changes state. In

this arrangement the engine stalls because it cannot produce sufficient current to be driven through the impedance 41. The value of impedance 41 is selected for the particular type of prime mover driven alternator 10 used such that the prime mover driven alternator cannot produce sufficient current to be driven through the resistor 41 so that the engine stalls.

After a suitable period of time for the prime mover driven alternator to stall, in this example 1.5 ms, switch 31 of the "make before break" switch arrangement of switches 31 and 51 is opened to disconnect the prime mover driven alternator from the mains 20 to produce the effective circuit shown in figure 7. Substantially less or no arcing is produced as the prime mover driven alternator is already stopped before it is disconnected from the mains supply 20.

When the prime mover driven alternator is disconnected from the mains 20 in an emergency situation, for example because the current detected at meters 32 or 44 is outside normal parameters, then switch 51 is closed and switch 31 is opened without waiting for the remaining heat in the Stirling engine to be used up. This should prevent the prime mover driven alternator from suffering any damage due to operation outside its normal conditions.

The arrangement of the control system for controlling switches 31, 51, 43, 52 in the manner described above is shown in Figure 8.

The controller 101 which may be a microprocessor or a computer for example has data links 110, 111 to meters 32 and 44 respectively and a data link 112 to temperature detector 15 on the Stirling engine. The controller 101 also has actuating links 115, 116 to "make before break" switch arrangement 31, 51 and "break before make" switch arrangement 43, 52 respectively.

The sequence of operations followed by the control system for connecting the prime mover driven alternator 10 to the mains electricity supply 20 is shown in Figure 9.

At step 201 the connector arrangement 1 is initially put into the condition in which:

SWITCH 31 is OPEN
SWITCH 43 is OPEN
SWITCH 51 is CLOSED
SWITCH 52 is CLOSED

At step 202

SWITCH 52 is OPENED and

SWITCH 43 is CLOSED

At step 203

A reading is taken from meter 44 and if it is outside expected conditions emergency shut down is activated at step 208. If the reading is inside expected conditions the control means proceeds to step 204.

At step 204

SWITCH 31 is CLOSED and
SWITCH 51 is OPENED

At step 205

A reading is taken from meter 32 and if it is outside expected conditions emergency shut down is activated at step 208. If the reading is within expected conditions the control means proceeds to step 206.

At step 206

SWITCH 43 if OPENED and
SWITCH 52 is CLOSED

At step 207

Meter 32 is monitored and if a reading is taken which is outside expected conditions emergency shut down is activated at step 208. Otherwise the system continues with this switch arrangement until disconnection is required as shown in Figure 9.

The sequence of operations followed by the control system for disconnecting the prime mover driven alternator 10 from the mains electricity supply is shown in Figure 10.

Initially

SWITCH 31 will be CLOSED
SWITCH 43 will be OPEN
SWITCH 51 will be OPEN and
SWITCH 52 will be CLOSED

At step 301 the heater for the Stirling engine is turned off and the temperature of the Stirling engine is monitored on line 112 until it reaches a critical temperature at which the engine begins drawing or is about to draw power from the mains. When this temperature is reached the control means proceeds to step 302.

At step 302 "make before break" switch arrangement 31, 51 is activated such that

SWITCH 51 is CLOSED and then
SWITCH 31 is OPENED

For emergency shut down the control system proceeds directly to step 302.

A Stirling engine driven alternator 10 and connector arrangement 1 can be transported with the connector arrangement 1 arranged with switches 31 and 43 open and switches 51 and 52 closed to produce the effective circuit shown in Figures 2 and 7. In this condition the piston of the Stirling engine is held substantially stationary so that no damage will be caused to the Stirling engine by movement or vibration during transportation.

The use of mechanical switches to perform the shutdown sequence rather than an external timing device enables shutdown to be performed even in the event of loss of the power supply. The connector arrangement 1 is able to provide both connection and disconnection from the mains power supply with the same components thus lowering the component count by providing dual functionality.

The connector arrangement 1 provides both a reliable mains supply connection and a safe instant disconnection in the event of loss of mains electricity supply. The method relies on connection to a circuit with an existing alternating current such as the mains.

As well as using the full circuit design, part of the circuit may be used for a particular connection or disconnection application. For example the disconnection circuit could be used for a stand alone generator and the connection circuit could be used for grid independent starting.

CLAIMS

1. A method of connecting a prime mover driven electrical alternator arranged to generate a current between two terminals to a circuit with an existing alternating current, the method comprising

connecting an impedance of such a value between the terminals of the alternator that the prime mover arranged to drive the alternator substantially cannot move and cannot make the alternator generate a current,

initialising the prime mover so that it is in a suitable condition to drive the alternator at the frequency of the alternating current in the circuit to which it is to be connected and

connecting the terminals of the alternator to a circuit with an existing alternating current to cause the alternator to start movement of the prime mover.

2. A method according to claim 1, wherein the prime mover is a Stirling engine and the alternator is a linear alternator.

3. A method according to claim 2, in which the Stirling engine is initialised by supplying heat to one end of its piston chamber.

4. A method according to any of the preceding claims in which the circuit with an existing current is the mains electricity supply.

5. A method according to any of the preceding claims, in which the terminals of the alternator are connected to a circuit with an existing alternating current through an impedance.

6. A method according to claim 5, in which the impedance through which the terminals of the alternator are connected to a circuit with an existing alternating current is subsequently short circuited.

7. A method according to any of the preceding claims, in which after the terminals of the alternator are connected to a circuit with an existing alternating current, the characteristics of the current passing through that connection are checked to determine whether they are within expected parameters.

8. A method according to claim 6, in which the characteristics of the current passing through the short

circuit are checked to determine whether they are within expected parameters.

9. A method according to claim 7 or claim 8, wherein if the characteristics of the current are outside expected parameters the alternator is disconnected from the circuit with an existing alternating current.

10. A method of connecting a prime mover driven electrical alternator arranged to generate a current between two terminals to a circuit with an existing alternating current substantially as hereinbefore described with reference to the accompanying drawings.

11. A method of disconnecting a prime mover driven alternator from a circuit with an existing alternating current comprising

connecting an impedance in parallel with the prime mover driven alternator, the impedance having a sufficiently low impedance value to require a current in excess of that which the alternator is able to deliver to prevent the prime mover from driving the alternator and thus stalling the prime mover and

disconnecting the alternator from the circuit with an existing alternating current.

12. A method according to claim 11, in which the prime mover is a Stirling engine and the alternator is a linear alternator.

13. A method according to claim 12, in which the Stirling engine has a heater and the heater is turned off and heat in the Stirling engine is used up before the impedance is connected in parallel with the alternator to stall the Stirling engine.

14. A method according to any of claims 11 to 13 in which the circuit with an existing alternating current is the mains electricity supply.

15. A method of disconnecting a prime mover driven alternator from a circuit with an existing alternating current substantially as hereinbefore described with reference to the accompanying drawings.

16. An apparatus for connecting a prime mover driven alternator to a circuit with an existing alternating current comprising

an impedance switchable into and out of a parallel arrangement with the alternator, the impedance being of sufficiently low value that the prime mover cannot drive

the alternator to produce a current around the impedance when connected in parallel with the alternator, and

a switch to connect the alternator to a circuit with an existing alternating current.

17. An apparatus according to claim 16, including a control means arranged to connect the impedance into a parallel arrangement with the alternator, arranged to disconnect the alternator from a parallel arrangement with the alternator and arranged to connect the alternator to a circuit with an existing alternating current.

18. An apparatus according to claim 17, wherein the control means is arranged to disconnect the impedance from a parallel arrangement with the alternator before it connects the alternator to a circuit with an existing alternating current.

19. An apparatus according to claim 17, wherein the control means is arranged to disconnect the impedance from a parallel arrangement with the alternator after it connects the alternator to a circuit with an existing alternating current.

20. An apparatus according to any of claims 16 to 19, wherein the alternator is connected to a circuit with an existing alternating current through an impedance.

21. An apparatus according to claim 20, including means to monitor the characteristics of the current passing through the impedance connected between the alternator and a circuit with an existing alternating current.

22. An apparatus according to claim 21, wherein the control means is arranged to short circuit the impedance connected between the alternator and a circuit with an existing alternating current if the characteristics of the current passing through the impedance are within desired parameters.

23. An apparatus for connecting a prime mover driven alternator to a circuit with an existing alternating current substantially as hereinbefore described with reference to the accompanying drawings.

24. An apparatus for disconnecting a prime mover driven alternator from a circuit with an existing alternating current comprising

an impedance switchable into a parallel arrangement with the alternator, the impedance being of sufficiently

low value that the prime mover cannot drive the alternator to produce a current around the parallel impedance and

a switch to disconnect the alternator from the circuit with an existing alternating current.

25. An apparatus according to claim 24 including a make-before-break switch to connect the impedance into a parallel arrangement with the alternator before disconnecting the alternator from the circuit with an existing alternating current.

26. An apparatus according to claim 24 or claim 25, wherein the prime mover driving the alternator is a Stirling engine.

27. An apparatus according to claim 26, wherein supply of heat to the Stirling engine is interrupted before the impedance is switched into a parallel arrangement with the alternator.

28. An apparatus for disconnecting a prime mover driven alternator from a circuit with an existing alternating current substantially as hereinbefore described with reference to the accompanying drawings.

FIG. 1.

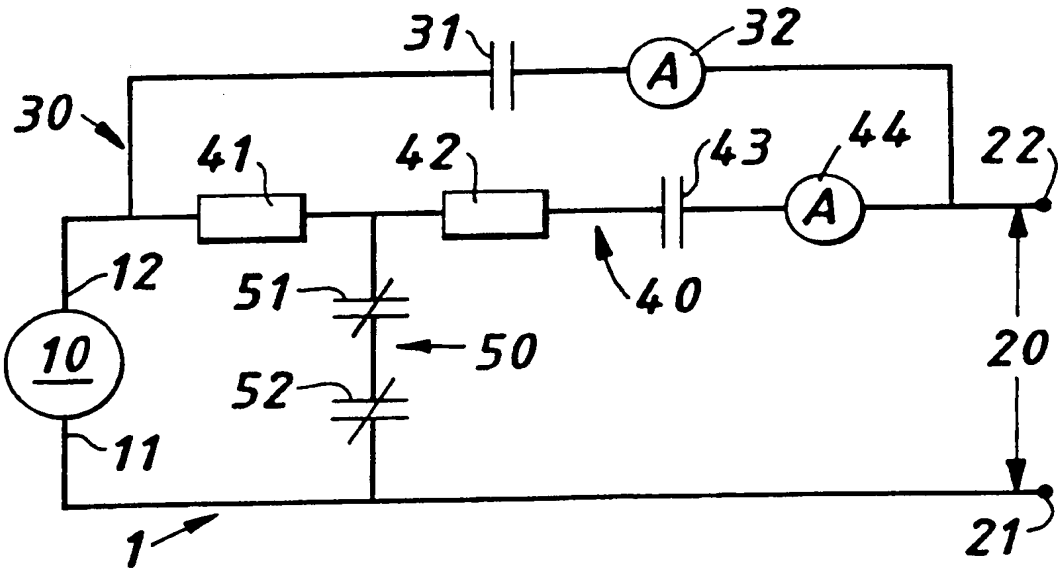


FIG. 2.

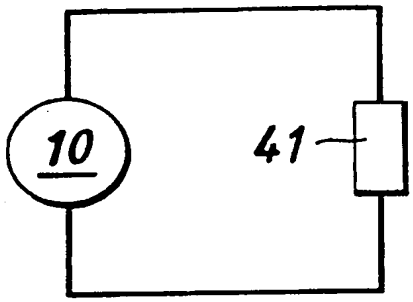


FIG. 3.

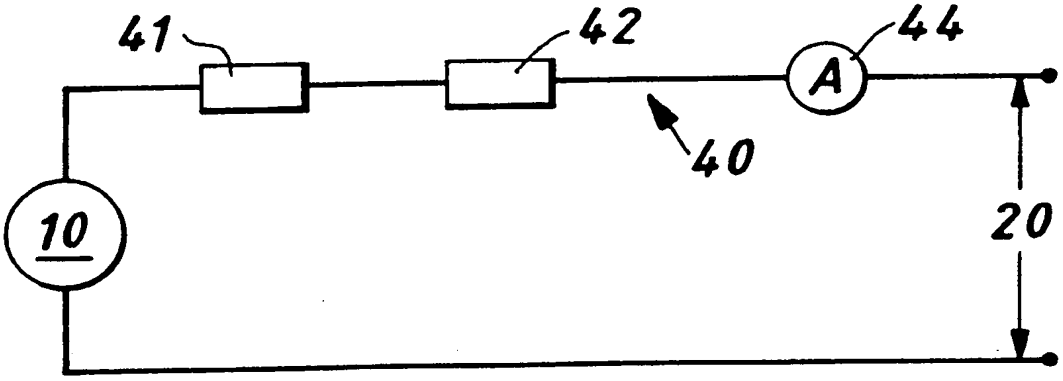


FIG. 4.

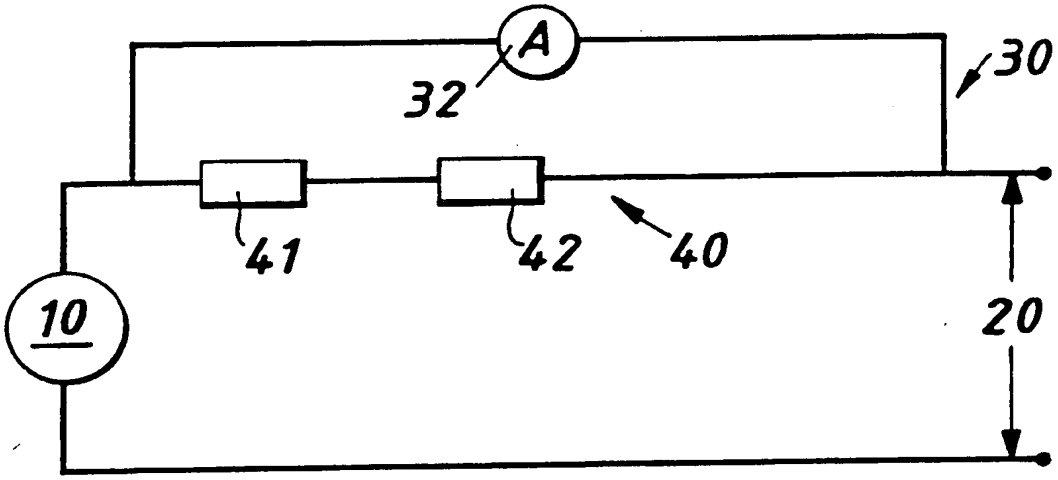


FIG. 5.

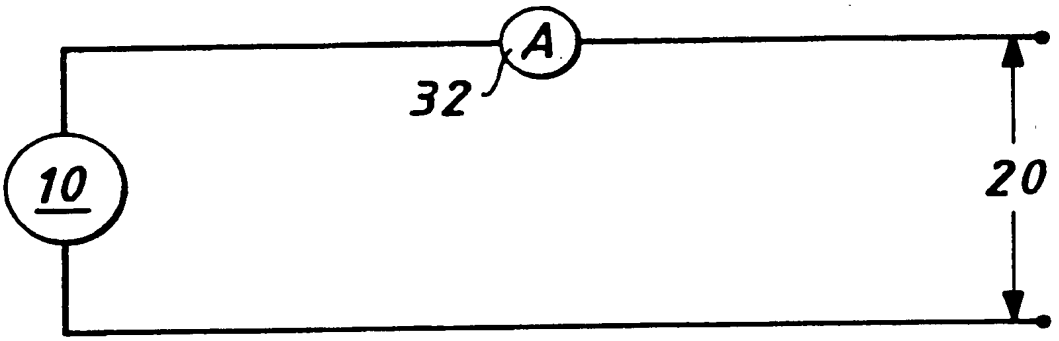


FIG. 6.

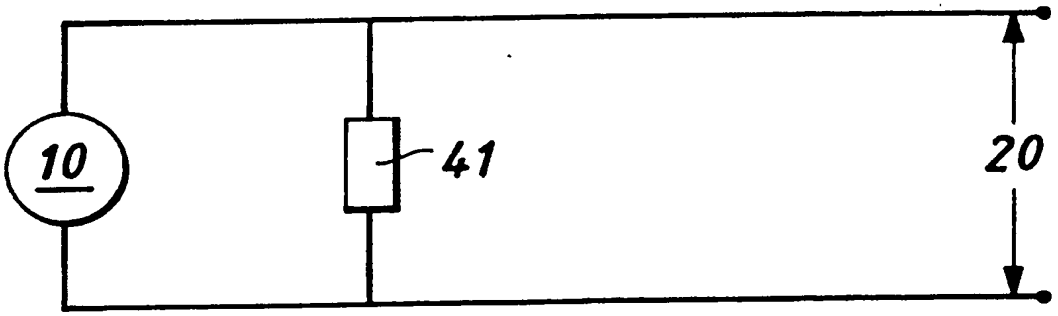


FIG. 7.

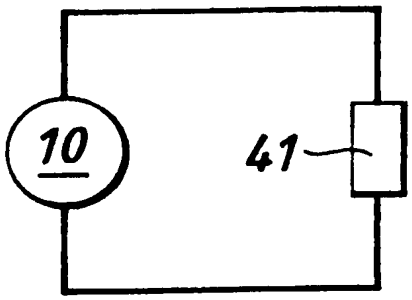
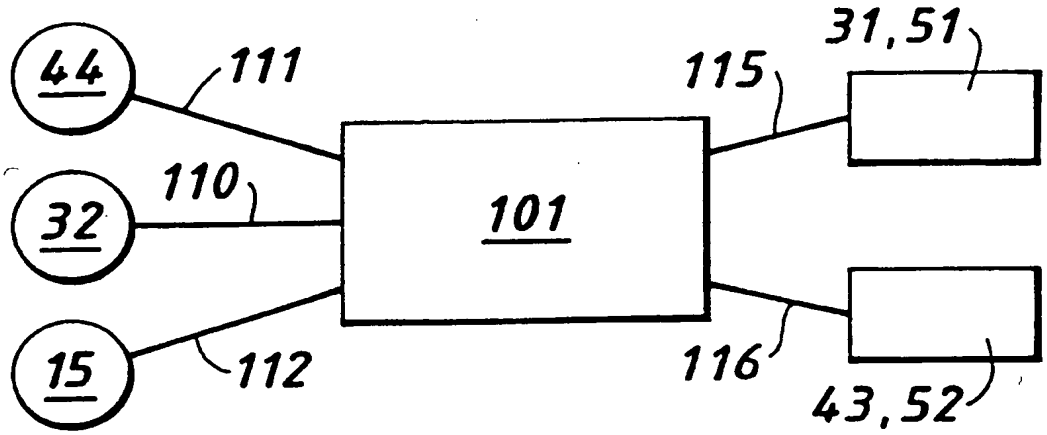


FIG. 8.



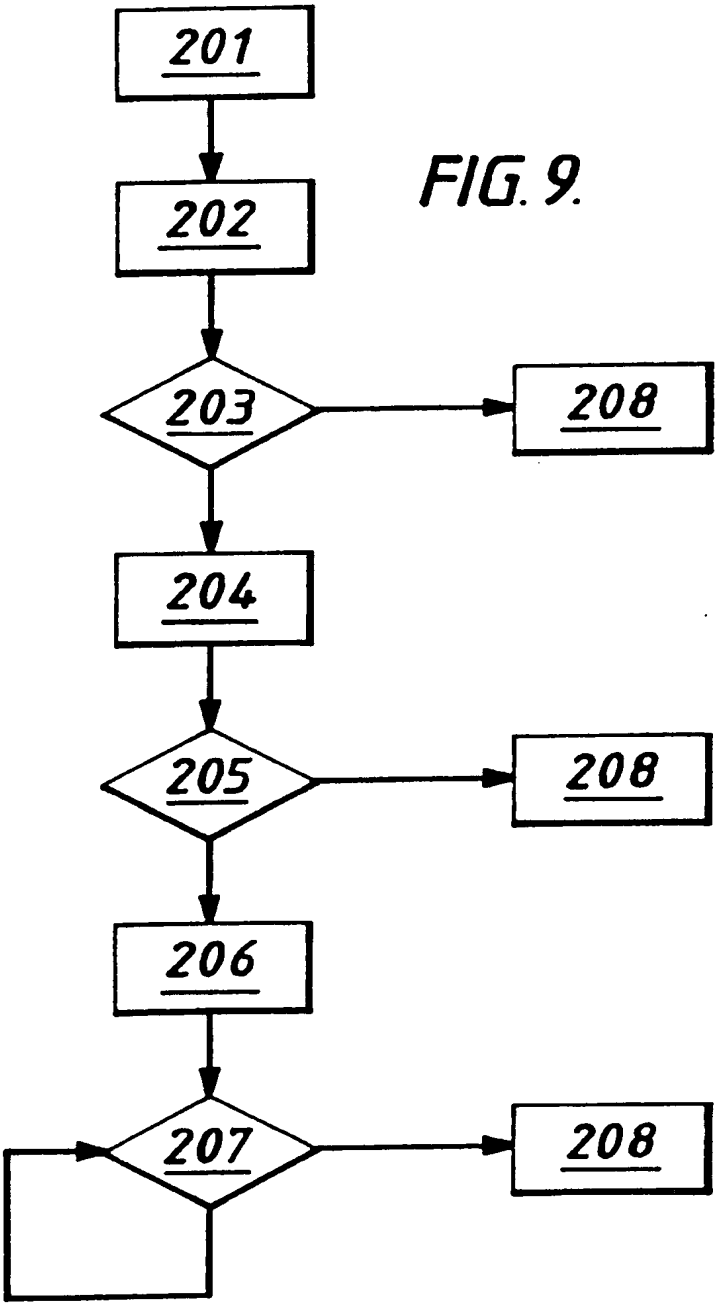


FIG. 9.

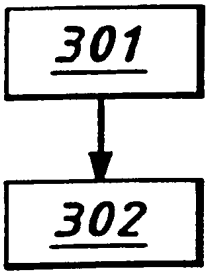


FIG. 10.

INTERNATIONAL SEARCH REPORT

Int tional Application No
PCT/GB 01/00840

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F02N11/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F02N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 841 216 A (OKADA YOSHIMI ET AL) 20 June 1989 (1989-06-20) abstract column 2, line 23 - line 43	1-28
A	US 4 642 547 A (REDLICH ROBERT W) 10 February 1987 (1987-02-10) abstract column 1, line 3 - line 10	1-28
A	US 5 998 976 A (STEFFAN BERNHARD) 7 December 1999 (1999-12-07) abstract	1-28

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☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
13 July 2001	23/07/2001

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Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
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Marannino, E.

Form PCT/ISA 210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int ional Application No
PCT/GB 01/00840

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4841216 A	20-06-1989	JP 1030500 A	01-02-1989
		FR 2616983 A	23-12-1988
		GB 2206751 A,B	11-01-1989
US 4642547 A	10-02-1987	NONE	
US 5998976 A	07-12-1999	DE 19646043 A	14-05-1998
		WO 9821805 A	22-05-1998
		EP 0875089 A	04-11-1998
		JP 2000503519 T	21-03-2000